

Mid-season determinations of nitrogen need to maximize yield and optimize inputs.

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The annual variability of yields in winter wheat production creates a conundrum when the ultimate goal is the production of maximum yields while minimizing inputs. The optimization of nitrogen (N) inputs becomes absolutely necessary due to the current market volatility and concentration on environmental stewardship. In 1971, a long-term, winter wheat fertility study was established in north-central Oklahoma. The 38-yr maximum yield ranged from 1,422 kg/ha to 5,935 kg/ha with an average of 3,011 kg/ha and standard deviation of 1,016.56 kg/ha. The average optimum N rate over the 38 years was 59 kg/ha. However, the optimum annual rate ranged from a minimum of 0 kg/ha to a maximum of 160 kg/ha with a standard deviation of 48 kg/ha. Yield goals and traditions lead the area producers N rate recommendation tools. For this region, total precipitation and the distribution of the events is the greatest yield determining factor. Many producers decide total N applications before the seed is sown, which lends to excessive N application in most years and a loss of yields in others. The technique of using optical sensor to determine midseason N rates has been implemented to account for the temporal and spatial variability experienced by every producer. Utilizing crop canopy reflectance measures (NDVI) and growing degree day units, yield potential can be determined prior to Feekes' growth stage 6. Yield potential combined with a measurement of N response (reference strips and the response index) a fertilizer N rate can be determined. This technique has been developed over many environments and varieties. Studies show on average a benefit of \$20/ha in winter wheat through the use of these technologies. The sensor and reference strip approach also allows for the ability to account for varietal differences in nitrogen need and use efficiency.

Wheat tolerance to aluminum toxicity in Asian and U.S. wheat.

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Aluminum (Al) toxicity is a major constraint for wheat production in acidic soils worldwide and especially in the southern Great Plains. Growing Al-tolerant cultivars is one of the most effective approaches to reduce Al damage. Malate release from root tips is considered a major mechanism for Al tolerance. Recently, citrate efflux has been suggested as an additional mechanism. A major quantitative trait locus (QTL) for Al tolerance has been mapped on chromosome 4DL and an Al-activated malate transporter, *ALMT1*, was cloned from this QTL region. Several markers developed from both the gene coding and promoter regions of *ALMT1* have been used for marker-assisted selection (MAS). However, markers fully diagnostic for the QTL have not been found. To evaluate the effectiveness of previously reported markers in MAS and identify new QTL for Al tolerance, an association mapping population with 94 Asian cultivars and landraces and 211 U.S. elite winter wheat breeding lines was evaluated for Al tolerance in laboratory and field experiments and genotyped with 270 genome-wide markers, including all previously reported markers for Al tolerance. Association analysis was conducted separately in both Asian and U.S. groups as suggested from structure analysis. Hematoxylin staining identified 33% of the accessions as highly resistant in each group. Among these accessions, 93% amplified a large fragment (≥ 720 bp) of UPS4, a part of the *ALMT1* promoter. All highly susceptible accessions amplified a smaller fragment (438 or 469 bp). However, only 33% of the highly resistant Asian accessions amplified the large fragments of UPS4, and most Al-tolerant accessions and all Al-sensitive accessions amplified either of the smaller fragments. Sequence analysis indicated that some accessions in the Asian group carrying an identical allele at *ALMT1* differed widely in Al tolerance. Besides UPS4, one marker on 3BL and two new markers on 4A and 7A were associated with Al tolerance in the U.S. and Asian groups, respectively. Linkage mapping to validate the putative new QTL from the Asian source is in progress. Therefore, the QTL on 4DL is the major source of Al tolerance in U.S. germplasm, and UPS4 is an ideal marker for MAS of the QTL. Further exploring Asian sources of Al tolerance may lead to the discovery of new QTL for Al tolerance.